

Remarks/Arguments

Upon entry of the foregoing amendments, claims 1 to 13 and 17 to 20 will be pending in the present patent application. Claim 1 has been amended. Claims 14 to 16, and 21 to 26 have been canceled, without prejudice. In particular, claims 21 to 26 were previously withdrawn as being directed to non-elected subject matter and have now been canceled in view of the finality of the restriction requirement as indicated at page 2 of the Action. Applicants reserve the right to present claims 21 to 26 in a later-filed divisional patent application. Claim 14 was canceled because its recitations were added to independent claim 1.

The Action includes a rejection under 35 U.S.C. §§ 102(b) and 103(a). In view of the following remarks, reconsideration and withdrawal of the rejection are requested respectfully.

Summary of the Invention

To protect the exposed photoresist surface in selective anisotropic etching applications, it may be desirable to have a fluorocarbon plasma that is highly polymerizing to encourage the formation of the fluorocarbon polymer. However, if the etch reaction cannot compete with the polymerization reaction at the exposed dielectric surface, the thin fluorocarbon film can accumulate and the etch process may stop. To optimize the competing reactions of etching and polymerization, molecular oxygen (O₂) is routinely added to the fluorocarbon etch plasma. The etch rate of the dielectric material may be increased if an optimal balance between the competing reactions can be achieved. Unfortunately, O₂ can attack the organic photoresist materials thereby increasing the photoresist etch rate. This may result in the undesirable decrease of etch selectivity of the dielectric material over the photoresist material within the substrate.

Applicants' claimed invention provides a mixture and a method comprising same for the removal of a substance from a layered substrate, that uses a fluorine-containing oxidizer such as hypofluorites, fluoro-peroxides, and/or fluoro-trioxides ***to decrease the amount of, or replace, molecular oxygen (O₂) as the oxidizer***, in conjunction with one or more fluorocarbons. The mixture has a ratio by volume of the fluorine-containing oxidizer to the fluorocarbon from 0.1:1 to 20:1.

The mixture and the method of the present invention may be used, for example, for selective anisotropic etching of a dielectric material from a layered substrate. In certain preferred embodiments, the mixture may be exposed to one or more energy sources sufficient to form active species, which then react with and remove the substance from the substrate.

In the present invention, it is believed that the use of a fluorine-containing oxidizer such as a hypofluorite, a fluoroperoxide, and/or a fluorotrioxide may be used in place of some, if not all of the O₂, ***thereby preventing the erosion of the mask or photoresist material***. Further, the fluorine-containing oxidizer may increase the dielectric etch rate by providing additional fluorine atoms into the etch reaction and subsequently the dielectric surface. Thus, the use of hypofluorites, fluoro-peroxides, and/or fluoro-trioxides to replace or significantly reduce the use of O₂ as the oxidizer in a mixture containing at least one fluorocarbon may enhance both the etch rate of dielectric materials and the etch selectivity of dielectric materials over photoresist materials.

Discussion of the Rejection Under 35 U.S.C. § 102(b)

Claims 1, 2, 5, 6, 8, 11, 17, and 18 have been rejected under §102(b) as allegedly being anticipated by German Patent No. DE 145348 to Bigl et al. ("the Bigl patent") (English translation attached hereto as Exhibit A). Applicants respectfully traverse this rejection

because the Bigl patent does not disclose each and every element of the claimed invention. *Verdegaal Bros. v. Union Oil Co. of California*, 2 USPQ.2d 1051, 1053 (Fed. Cir. 1987) (“A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.”).

Applicants’ claimed invention defines a mixture for etching a dielectric material in a layered substrate, the mixture comprises (1) a fluorocarbon (2) and a fluorine-containing oxidizer selected from the group consisting of a hypofluorite, a fluoroperoxide, a fluorotrioxide, and combinations thereof, wherein the mixture has a ***ratio by volume of the fluorine-containing oxidizer to the fluorocarbon from 0.1:1 to 20:1***. Applicants’ claimed invention requires ***at least two components***.

Applicants submit respectfully that the Bigl patent does not teach or suggest Applicants’ claimed mixture comprising a fluorocarbon ***and*** a fluorine-containing oxidizer. To the extent that the Bigl teaches a mixture of a fluorocarbon and a fluorine-containing oxidizer, the Bigl patent does so inadvertently and in such a way that is insufficient to place Applicants’ claimed invention in the public’s possession as is required by 35 U.S.C. § 102.

Indeed, the invention described by the Bigl patent is the use of fluorine ions in reactive ion beam etching. The Bigl patent teaches that one of the possible sources of fluorine ions is from CF₃OF, along with certain fluorocarbons such as CF₄ and CF₃H (see English Translation at page 3). Although Bigl teaches that the ion source could include “mixtures of” CF₃OF and CF₄ and CF₃H, Bigl, ***as a whole***, is directed to the use of such components ***alone***. In this regard, the Bigl patent’s two working examples utilize CF₃H and CF₃OF, respectively. Thus, the Bigl reference, ***as a whole***, does not place Applicants’ claimed invention in the public’s possession.

Notwithstanding their disagreement with the Action, Applicants have amended independent claim 1 to include the recitation “wherein the mixture has a ***ratio by volume of***

the fluorine-containing oxidizer to the fluorocarbon from 0.1:1 to 20:1. Because the Bigl patent does not disclose mixtures of a fluorocarbon and a fluorine-containing oxidizer, the Bigl patent indeed does not teach or suggest such ratio. Accordingly, reconsideration and withdrawal of the rejection under 35 U.S.C. § 102(b) in view of the Bigl patent are requested respectfully.

In addition, the Bigl patent does not render newly amended claim 1 obvious under 35 U.S.C. § 103(a) because the Bigl patent does not teach or suggest the the claimed invention to one of ordinary skill in the art.

Applicants have surprisingly discovered that the claimed mixture comprising a fluorocarbon ***and*** a fluorine-containing oxidizer ***significantly*** increases the etch selectivity over the use of either a fluorocarbon or, for example, CF₃OF alone. In this regard, Applicants specification at Table 3 (page 14) demonstrates that the SiO₂/photoresist etch selectivity for an etch performed with an ion beam obtained by ionization of CF₃OF such as that of Example 2 of the Bigl patent is only about 0.50 at its best. Similarly, Applicants specification at Table 2 (page 13) demonstrates that the SiO₂/photoresist etch selectivity for an etch performed with an ion beam obtained by ionization of a fluorocarbon, C₄F₆, and O₂, such as that of Example 1 of the Bigl patent is only about 3.2 at its best. In contrast, Applicants specification at Table 1 (page 12) demonstrates that the SiO₂/photoresist etch selectivity for an etch performed with an ion beam obtained by ionization of a mixture according to Applicants' claimed invention is ***as high as 4.5***. Indeed, such surprising results are due to the synergistic effects of Applicants' claimed composition. Such synergism is ***not*** taught or suggested by the Bigl patent. Accordingly, Applicants submit respectfully that amended claim 1 is patentable over the Bigl patent.

Discussion of the Rejections Under 35 U.S.C. § 103(a)

Claims 14 to 16 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over the Bigl patent. Applicants respectfully traverse this rejection because, as discussed above, the Bigl patent does not teach or suggest Applicants' claimed invention.

Claims 3 and 4 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over the Bigl patent in view of U.S. Patent No. 5,176,790 ("the 790 patent"). Applicants respectfully traverse this rejection.

To establish a *prima facie* case of obviousness, it is fundamental that the prior art must teach or suggest all the claim limitations. MPEP § 2143.

As noted above, the Bigl patent does not teach each and every imitation of Applicants' claimed invention as defined by, for example, independent claim 1 as amended above. Accordingly, even if the 790 patent did teach or suggest the limitations of the dependent claims 3 and 4 (*arguendo*), such combination is still incapable of teaching or suggesting each and every limitation of Applicants' claimed invention.

Claim 7 has been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over the Bigl patent in view of U.S. Patent No. 6,403,491 ("the 491 patent"). Applicants respectfully traverse this rejection.

As noted above, the Bigl patent does not teach each and every imitation of Applicants' claimed invention as defined by, for example, independent claim 1 as amended above. Accordingly, even if the 491 patent did teach or suggest the limitations of the dependent claim 7 (*arguendo*), such combination is still incapable of teaching or suggesting each and every limitation of Applicants' claimed invention.

Claims 9 and 10 have been rejected under 35 U.S.C. § 103(a) as allegedly being unpatentable over the Bigl patent in view of U.S. Patent No. 6,242,359 to Misra ("the 359 patent"). Applicants respectfully traverse this rejection.

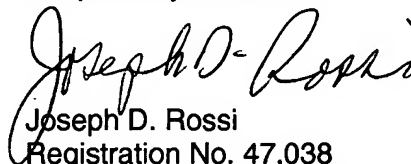
As noted above, the Bigl patent does not teach each and every imitation of Applicants' claimed invention as defined by, for example, independent claim 1 as amended above. Accordingly, even if the 359 patent did teach or suggest the limitations of the dependent claims 9 and 10 (*arguendo*), such combination is still incapable of teaching or suggesting each and every limitation of Applicants' claimed invention. Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. § 103(a) is requested respectfully.

Conclusion

Applicants believe that the foregoing constitutes a complete and full response to the Action of record. Applicants respectfully submit that this application is now in condition for allowance. Accordingly, an indication of allowability and an early Notice of Allowance are respectfully requested.

The Commissioner is hereby authorized to charge the fee required and any additional fees that may be needed to Deposit Account No. 01-0493 in the name of Air Products and Chemicals, Inc.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Joseph D. Rossi". The signature is written in a cursive style with a large, stylized "J" and "R".

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